Abiotic and Invertebrate Model

Great Salt Lake Food Web Modeling for Selenium Bioaccumulation

August, 2007

Major components that determine water column dissolved and particulate selenium concentrations:

- Influent loading from streams, canals, and the north lake (gain)
- Water-column sequestration, uptake, and settling (loss)
- Water-column dissolution and remineralization (gain)
- Surficial sediment layer dissolution and diffusive loss as well as resuspension of particulates (gain)
- Shoreline edge drying and rewetting as a selenium remobilization mechanism (gain)
- Permanent sediment burial (loss)
- Volatilization loss of gaseous compounds of selenium (loss)

Modeling Approaches

- Gains = External loading (Streams and North Lake)
- Losses = Permanent sediment burial and volatilization
- **Existing water column + (Gains – Losses) = Future average water column conditions**
- Empirical model approach = Model relationships between loading and loss to predict water-column seasonal averages (not yet available but possible)
- Mechanistic model approach = Detailed loss processes and short-term gains (resuspension, shoreline) combined with microbial rate processes and full limnological model (brine layer, stratification, seasonality, etc….) to predict water column conditions at any time

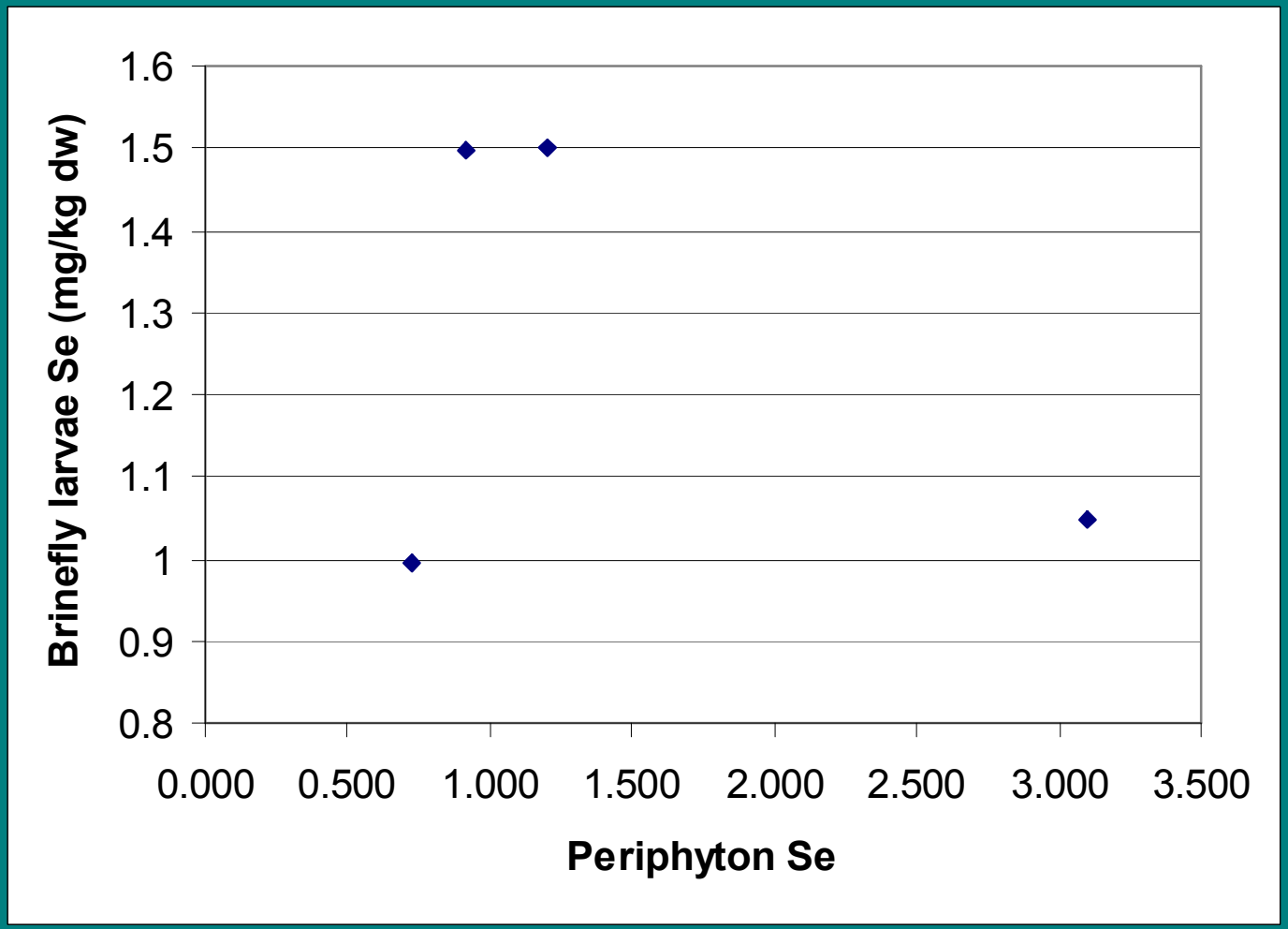
Basic Model Structure

- Simple mass-balance approach
- Selenium loading versus loss processes
- Model produces average conditions for lake and biota for pre-selected time intervals (variable)
- Based on transfers from sediment and water to invertebrates; Avian Model from there to birds

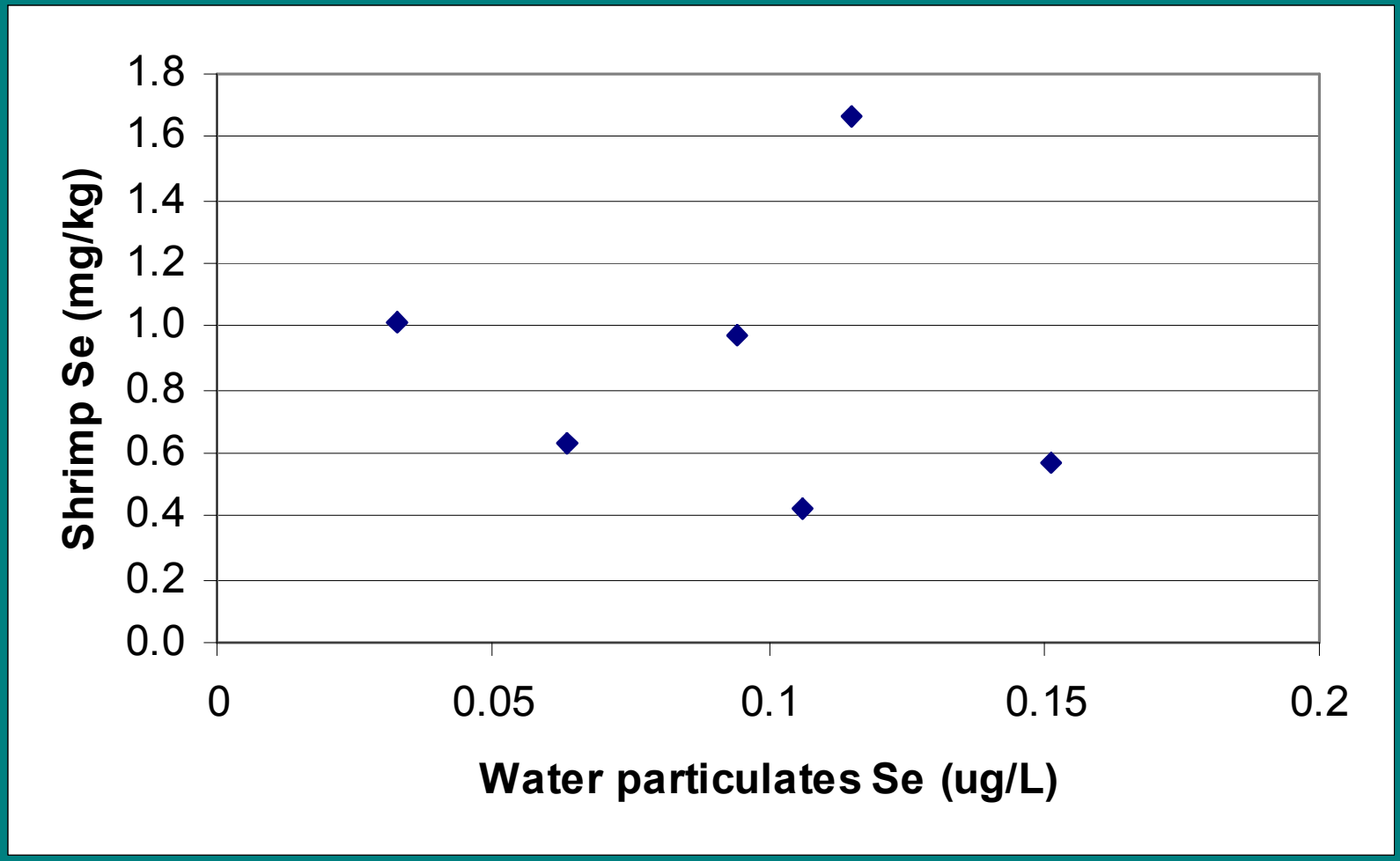
Predicting future, annual average water column selenium concentrations using 2006 gain and loss terms applied to 2006 baseline concentrations (from Johnson et al., 2007 and Naftz et al., 2007). Preliminary example values, only.

Parameter	Statistic	Measured (or Estimated) Annual Value for 2006 (variable units)	Modeled Value for Future Condition
Influent Se load	Total load estimated	1500 kg (high est.)	
Sedimentation loss	Total lakewide value	250 kg	
Volatilization loss	Estimated based on wind speed and water temperature	504 kg	
Average water column total Se concentration	Upper water column lakewide average	0.510 ug Se/L	0.585 ug Se/L
Average water column particulate Se concentration	Upper water column lakewide average	0.084 ug Se/L	0.097 ug Se/L
Average lakewide shorezone sediment Se concentration	Measured in 2006, modeled from water for future.	0.523 mg Se/kg dw	0.600 mg Se/kg dw

Periphyton-to-brine fly relationship



Particulates-to-brine shrimp relationship



Transfer Factors from Abiotic Components of the Model to Invertebrates and Modeled versus Average 2006 Measured Values. Preliminary example values, only.

Invertebrate Life Stages	Transfer Factor Formula	Transfer Factor	2006 Measured Values (mg Se/kg dw)	Modeled Future Values (mg Se/kg dw)
Brine fly: Larvae Pupae Adults	 Larvae Se/periphyton Se Pupae Se/larvae Se Adult Se/pupae Se	 1.17 1.12 1.29	 1.3 1.4 1.8	 1.5 1.6 2.1
Brine shrimp: Adults Cysts	 Adult Se/particulate Se in water Cyst Se/adult Se	 9.99 1.3	 0.85 1.1	 0.97 1.3
Midge larvae	Midge Se/sediment Se	3.82	2.0	2.3
Corixids	Corixid Se/brine shrimp Se	1.38	2.3	2.7

Model Assumptions

- Describes steady-state conditions for pre-defined interval (monthly, quarterly, annual)
- Simple ratio or regression relationships between water and sediment and inorganic media to invertebrates
- Lakewide averages now, but could be constructed for smaller areas

Linkage to Avian Model

- Lakewide selenium averages of invertebrates estimated in abiotic model to use in the avian model for determining bird diet selenium